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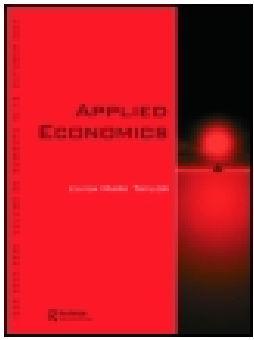
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Dutch inventory investment: are capital market imperfections relevant?

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This paper analyses inventory investment using a balanced panel of 82 Dutch firms. We start from the Lovell (1961) inventory model and amend it with cash flow to introduce capital market imperfections. The empirical evidence provides support for the relevance of capital market imperfections in explaining Dutch inventory investment. The results suggest that cash flow is a relevant variable omitted from the original Lovell model. The study provides a better understanding of inventory behaviour in general.

I. INTRODUCTION

Macroeconomic explanations of business fluctuations often address the role of inventory investment. Especially inventory disinvestment is found to be able to account for much of the output movement during recessions. For this reason, macroeconomic inventory stocks are popular as a component of leading business cycle indicators. Unexpected negative shocks, such as contractionary monetary policy, are considered to be the causes of initial downturns. Contractionary monetary policy adversely affects a firm's balance sheet position and increases its demand for external funds or a decline in monetary buffer stocks. If capital markets appear to be imperfect, some firms are most likely to be financially constrained. Since inventory formation faces low adjustment costs and hence inventory investment is largely reversible, it is likely that inventories are to be adjusted quickly.

Inventory formation is found to be difficult to explain. The seminal Lovell (1961) model that links inventories with sales in a stock adjustment equation is popular up to now. However, the Lovell model is blurred by a number of empirical phenomena. First, the Lovell model only considers shocks to sales but not that to production. This makes the Lovell model suitable to analyse the stockout avoidance but not the production smoothing hypothesis. Second, changes in the real interest rate are found to

have low explanatory power in the inventory equation at the macroeconomic level (see Blinder and Maccini, 1991). The latter implies that it is difficult to explain why changes of the monetary stance affect inventories and output so strongly.

Recent evidence shows that microeconomic studies reveal more essential properties of investment behaviour in general, and inventory investment in particular. Especially if one assumes capital markets to be imperfect, differences between behaviour of various categories of firms appear to be significant. A few examples of firm-level inventory models incorporating capital market imperfections are known for the US economy (see Kashyap *et al.*, 1993; Carpenter *et al.*, 1994; Kashyap *et al.*, 1994) and UK economy (Milne, 1991; Guariglia, 1999). If firms are heavily dependent on retained earnings, it can be explained why inventories are so procyclical. It can also be explained why inventory investment does not respond to the changes in the real interest rate that quickly.

This paper uses a panel containing firm-level data for 82 firms over the period 1984–1995 to estimate a model of Dutch inventory investment. The goal is threefold. First, since there are no recent studies available on Dutch inventory investment at the firm-level, this study aims to improve the understanding of the Dutch case. Second, by augmenting the Lovell model with cash flow financial factors are linked to inventory investment, which provides us

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an improved understanding of inventory behaviour in general.¹ Third, the relevance of capital market imperfections to inventory investment is examined. This is done by testing cash flow effects across different groups of firms characterized by different proxies for financial constraints.

Three classifications are used: large versus small firms, firms with low versus high dividend payout, and low-indebted versus high-indebted firms. The stock adjustment inventory equation augmented by cash flow is estimated for the sub-samples separately. It is expected that small firms are likely to be constrained more than large firms. Especially in The Netherlands, a few very large firms are typical multinational corporations, which face hardly any problem on capital markets. With regard to dividend payout behaviour, the *a priori* hypothesis is less clear. Whited (1992) argues that low-dividend payout firms are probably in financial distress. Gilchrist and Himmelberg (1995) argue that this holds typically for firms that do not pay dividend at all. If firms pay dividend, they will try to stabilize the dividend ratio, which implies that dividends are disbursed first from earnings. Therefore, high dividend payout firms, if they have a stable dividend ratio, are likely to be more cash flow dependent.² The last subdivision, low-indebted versus high-indebted firms, has a similar ambiguity. High debt may signal either a good track record in getting loans or being fully loan dependent. This requires more caution about the results concerning dividend ratio and debt splitting.

The remainder of the paper is organized as follows. The next section introduces the standard Lovell inventory model and some potential problems to be dealt with in empirical test. Section III describes the data and sample characters used in this study. Estimation results are discussed in Section IV. Section V concludes the paper.

II. THE MODEL

There are two stylized theoretical explanations of inventory formation. The first explanation assumes that shocks to the cost of production will cause procyclical movement of inventories because times of low cost are good times to produce and build up inventories. This approach is popularized by Holt *et al.* (1960). Usually a representative firm is

assumed to aim at minimizing production and inventory costs over an infinite horizon. Production costs are included in levels and changes in production, whereas costs incur when inventory stock diverges from the level of sales. The second explanation assumes that there are costs of adjusting production and a strong accelerator motive. The accelerator motive links today's inventories to tomorrow's expected sales, perhaps because of concerns about stockouts. Since sales are serially correlated this will cause inventories to move with sales and the cycle. Both explanations obtain empirical support, but the evidence is mixed (see Ramey and West, 1997).

The stock adjustment equation has been used for decades in empirical inventory research. Since the Lovell (1961) inventory model is regarded as the basic framework of stock adjustment equation in empirical studies, it is important to start with the original Lovell (1961) inventory model and to interpret it as a stockout avoidance rather than a production smoothing model. By augmenting the Lovell model with financial indicators, capital market imperfections will be introduced into the inventory formation equation. It is expected that an improved understanding of inventory behaviour will develop in general.

Following Lovell (1961), it is assumed that the actual stock of inventories (V) depends on the planned stock of inventories (V^p) and unanticipated changes in sales.

$$V_{it} = V_{it}^p + [E_{t-1}S_{it} - S_{it}] \quad (1)$$

$E_{t-1}S_{it}$ is the expected value of sales at the beginning of period t and S_{it} denotes the actual value of sales in period t . The planned stock of inventories is modelled by using a standard stock adjustment equation:

$$V_{it}^p = \lambda V_{it}^* + (1 - \lambda)V_{i,t-1} \quad (2)$$

V_{it}^* represents the target stock for firm i at time t , $V_{i,t-1}$ is the actual stock of inventories at the beginning of period t . λ is the parameter representing the adjustment speed of inventories.

By combining Equations 1 and 2, one obtains

$$\Delta V_{it} = \lambda(V_{it}^* - V_{i,t-1}) - (S_{it} - E_{t-1}S_{it}) \quad (3)$$

where ΔV_{it} is the flow of inventory investment by firm i in period t . Based on this model, the adjustment of inventories is partially proportional to the gap between

¹ The other approach of linking capital market imperfections to inventory investment is to introduce financial factors in the firm's objective function and derive the inventory investment equation under some constraints. Since this study works with the Lovell model, which itself is a reduced form of inventory equation, the alternative approach in which one puts the proxy for capital market imperfections into the reduced form of inventory equation directly was adopted.

² The consideration of the stockholders' behaviour may blur the dividend payout splitting in some cases. The level of dividend payout of the firm may be influenced by the stockholders of the firm. If stockholders care more about the long-run value of the firm, the level of dividend payout in the short-run may have nothing to do with financial distress facing the firm. However, it is not the case for the firms in our sample. In The Netherlands stockholders have no power to influence the dividend payout decision made by the managers of the firm. Therefore one would expect that the consideration of the stockholders' behaviour on dividend payout dose not change the results significantly.

the target and the actual stock of inventories and entirely responds to the unexpected shocks to sales.

There are two unobservable variables in this basic model: the target level of inventory V_{it}^* and the expected value of sales $E_{t-1}S_{it}$. Lovell is followed by defining the target level of inventories as a linear function of expected sales

$$V_{it}^* = \alpha + \beta E_{t-1}S_{it} \quad (4)$$

where α is a constant. β represents the accelerator effect: if sales are expected to increase, firm's target stock of inventories will increase. The change in the stock of inventories will be brought about by changes in production. Hence, production adjusts so as to avoid stockouts.

Empirical test of the Lovell model requires a specification of expected sales. Again Lovell is followed. He models expected sales by a mixture of static expectations and perfect foresight:

$$E_{t-1}S_{it} = \gamma S_{i,t-1} + (1 - \gamma)S_{it} \quad (5)$$

When γ equals zero, we obtain perfect foresight results. If γ equals one, Equation 5 corresponds to static naïve expectations. By rewriting Equation 5 as $E_{t-1}S_{it} = S_{it} - \gamma(S_{it} - S_{i,t-1})$, it can be easily seen that in the case where $\gamma < 0$, firms overestimate sales when sales increase in time, and they underestimate sales when sales decrease in time. Hence, if γ happens to be negative, business cycles will be amplified by the expectation formation of firms.

By inserting Equations 4 and 5 in Equation 3 it follows that

$$\Delta V_{it} = g - \lambda V_{i,t-1} + \varphi S_{it} + \mu S_{i,t-1} \quad (6)$$

where $g = \lambda\alpha$; $\varphi = \lambda\beta - \mu$, and $\mu = (\lambda\beta + 1)\gamma$. Taking into account fixed effects and time effects, Equation 6 becomes

$$\Delta V_{it} = f_i + f_t - \lambda V_{i,t-1} + \varphi S_{it} + \mu S_{i,t-1} + \varepsilon_{it} \quad (7)$$

where f_i is the fixed specific constant; f_t represents a year-dummy firm effects and ε_{it} is the stochastic error. All structural parameters in Equation 7 can be identified. The study is interested in the accelerator effect (β) and the expectations formation coefficient (γ). Implied beta's will be calculated by $(\varphi + \mu)/\lambda$ and the implied expectations formation coefficient by (γ) by $\mu/(\lambda\beta + 1)$.

To improve upon the fit of the model and in order to test for the relevance of capital market imperfections, we amend the basic model Equation 7 with cash flow:

$$\Delta V_{it} = f_i + f_t - \lambda V_{i,t-1} + \varphi S_{it} + \mu S_{i,t-1} + \theta CF_{it} + \varepsilon_{it} \quad (8)$$

where CF_{it} is the measure of the current cash flow for firm i and θ is the marginal cash flow effect. It is expected that the cash flow effect should be weaker for firms with fewer information problems. However, cash flow probably signals firm's future profitability of capital. The standard pro-

cedure to correct for this is to include Tobin's Q (see Fazzari *et al.*, 1988) in the fixed investment equation. Therefore average Q is included in the preliminary regressions, which turned out to be insignificant in all experiments. This may suggest that Q is irrelevant to inventory behaviour although it is an important explanatory variable in the fixed investment equation. Another disadvantage of using cash flow is that there might be a monetary buffer effect. The monetary buffer is implied by the substitution effect between firm's inventories and liquid assets. Suppose there is a positive shock to demand, the desired (planned) inventory stock will increase. This leads to the lower planned cash flow stock in the firm's balance sheet. A firm can use its stock of liquid assets to adjust for the planned inventory formation and to substitute inventories for liquid assets. This is known as the monetary buffer effect. If it holds, the firm will not need more cash flow immediately after the demand shock is realized, instead it will reduce its cash balances first. To control for the monetary buffer effect, the stock of liquid assets was included in the cash flow augmented inventory equation, which takes the form

$$\begin{aligned} \Delta V_{it} = & f_i + f_t - \lambda V_{i,t-1} + \varphi S_{it} + \mu S_{i,t-1} \\ & + \theta CF_{it} + \tau L_{it} + \varepsilon_{it} \end{aligned} \quad (9)$$

where L_{it} represents the stock of total liquid assets of firm i in period t . In estimations all variables in levels are scaled by the beginning-of-period capital stock to eliminate size effects.

The estimation methodology follows. First, the basic Lovell model (Equation 7) was estimated for the whole sample and all sub-samples. The results without financial factors indicate the benchmarks for the structural parameters. Next, the cash flow augmented model (Equation 9) was estimated. This study is especially interested in the significance of the cash flow effect for different groups of firms, since that gives us information on the relevance of capital market imperfections. Moreover, the estimated values of the accelerator effect β and the adjustment speed parameter λ were compared between the basic and the augmented model.

III. THE DATA

The dataset contains 82 listed Dutch firms over the period 1984–1995 and is taken from the publication *Jaarboek van Nederlandse Ondernemingen*.

First, the sample was split by size. The average capital stock was chosen over the whole sample period as the proxy for the size of the firm. The top 42 firms were taken as large firms and the other 40 firms were considered to be small firms.

In addition to size splitting, the average value of the dividend ratio for each firm was calculated over the sample period. The firms with an average dividend ratio over 24% are in the high dividend payout group and the firms with the average dividend ratio below 14% are in the low dividend payout group. The high dividend payout group consists of 12 firms, whereas there are 31 firms in the low dividend payout group.

For debt splitting, the average of the ratio of debt to the capital stock was calculated for each firm over the sample period. The high debt group was defined as the group that consists of the top one-third firms and the low debt group as the one that consists of the lowest one-third firms in the whole sample. The high debt group contains 26 firms (one outlier is ignored). The low debt group consists of 27 firms.

Table 1 presents some relevant information on the firms characterized by different criteria. The table shows that firms in different sub-samples differ considerably. The mean and the median of the capital stock, inventories, sales, and cash flows are larger for large and low-indebted firms as compared to their opposite categories. Large and low-indebted firms also have smaller values of dividend ratio than small and high-indebted firms. High dividend payout firms have larger values of capital stock, sales, cash flows and debt than low dividend ratio firms.

Figure 1 shows the co-movement between inventories and cash flows for large and small firms, respectively. Comparing Figure 1-A and 1-B, it is noticed that: first, inventory investment is more volatile for small firms. The variance of inventory (scaled by the capital stock) for small firms over the whole sample period is 7.77 and that for large firms is 0.25. Second, the co-movement between inventories and cash flows is stronger for small firms. The correlation of the two variables for small firms is 0.79 and that for large firms is 0.47. In addition, other preliminary descriptive statistics show that Dutch firms in the sample are stockout avoidance rather than production smoothing motivated. The ratio of the variance of production to the variance of sales over the sample period is 1.032, which implies that production is more volatile than sales. Moreover, the correlation between inventory investment and sales is 0.174, which suggests that inventory investment responds to sales positively.

IV. ESTIMATION RESULTS

In estimations a macroeconomic business cycle effect was tested for by including year dummy variables. Since the time dummies happen to be insignificant, they were ignored in the final presentation of the estimation results. Because of space limitations we do not report the firm-specific intercepts either.

Table 2 presents estimation results for Equation 7. For the entire sample, the speed of adjustment (λ) equals 0.398,

and the composite coefficients φ and μ have values of 0.078 and -0.054 , respectively. The implied β equals 0.060. The implied γ is negative, implying overreactions in the expectations formation of firms. This happens to be so for all estimates (see also Tables 3 and 4). In addition, it is observed from Table 2 (also Table 3 and 4) that the estimates of long-run inventory to sales sensitivity (accelerator coefficient β) are positive in all but one cases, which supports the stockout avoidance motive for our sample firms.

Table 3 reports the estimation results for Equation 9. Table 4 reports the estimates of Equation 9 with lagged-one cash flows instead of current cash flows. Comparing the structural parameters in Table 2 with their counterparts in the other two tables, it is noticed that adding financial factors changes the values of structural parameters and their significance but not the performance of the model as a whole. Focusing on the accelerator coefficient β and the adjustment speed parameter γ , we notice that all β 's and γ 's change in the augmented models as compared with the benchmark values. Moreover, it shows a pattern that β and γ increase for unconstrained firms and they decrease for constrained firms loosely speaking. In the literature the popular stock adjustment equation based on the Lovell model implies a very weak accelerator effect and a very slow adjustment speed, which is inconsistent with the theory. In this sense, the results question the accuracy of the previous explanations of the Lovell-type inventory model and its related empirical outcomes. The previous studies based on the Lovell model have interpreted the adjustment of inventories as the only outcome of firm's response to demand shocks and it has nothing to do with the existence of capital market imperfections. The results strongly suggest that the original Lovell model, in which no proxies for capital market imperfections are taken into account, underestimates the accelerator effect and adjustment speed for unconstrained firms and overestimates them for constrained firms. In other words, if no capital market imperfections are taken into account, the effects of capital market imperfections on inventory behaviour are picked up by the accelerator coefficient β and the adjustment speed parameter λ . It is obvious that the estimated values of the structure parameters of the Lovell model are biased due to omitting the indicator of capital market imperfections. In this sense our results provide a better understanding of inventory behaviour in general.

The most important difference between financially unconstrained and constrained firms concerns the marginal effect of cash flow. In Table 3 it appears that the stock of liquid assets has a negative impact on inventory formation. Firms typically choose between holding inventory or cash but not the both. This supports the monetary buffer notion. Once controlling for this effect one can analyse the impact of cash flow for various subgroups. The estimated coefficient of cash flow for small firms is 0.572 and that for large firms is 0.048 (and insignificant). This is fully in line with

Table 1. Means and medians of selected firm characteristics 1984–1995 (unit: 10^6 Guilders)

	Capital stock (k)		Inventories (v)		Sales (s)		Cash flow (cf)		Debt (dt)		Dividend ratio (df)	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Size:												
Large	2745.02	454.01	954.68	163.49	7467.74	1838.29	611.68	122.27	2902.43	690.28	16.79	16.35
Small	53.39	32.01	41.82	27.11	375.59	219.99	18.26	10.73	90.74	55.23	17.55	17.14
Dividend:												
Low	1575.81	244.19	626.82	40.13	4482.84	471.55	323.17	38.41	1982.13	291.26	9.49	10.29
High	4383.29	83.65	1315.45	71.51	11575.97	1133.78	1008.38	32.67	3804.17	205.34	32.94	31.33
Debt:												
Low	2083.60	335.67	376.15	53.29	3968.17	629.74	429.74	73.11	1451.64	235.21	16.73	15.80
High	121.09	42.74	85.55	42.90	1010.07	455.51	43.19	19.02	292.05	140.64	19.06	20.70

Source: Own calculations from dataset taken from *Jaarboek van Nederlandse Ondernemingen*.

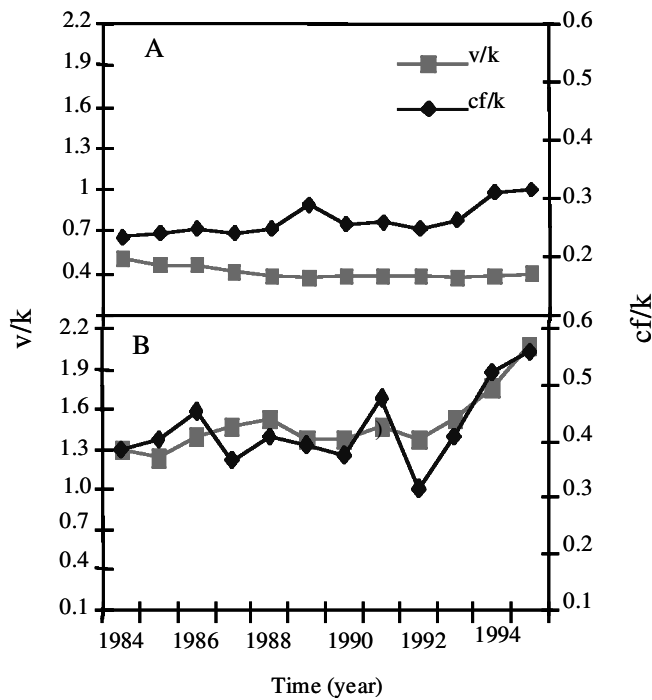


Fig. 1. Time series of v/k and cf/k for large (A) and small (B) firms

theory. Apparently large firms are less financially constrained and are less cash flow dependent.

The estimated marginal effect of cash flow for high dividend ratio firms is 1.408 and that for low dividend ratio firms is 0.128. These results provide support for Gilchrist and Himmelberg (1995). As they found, the results show positive and significant cash flow effect for high dividend payout firms, while the cash flow effect is not significant for low dividend payout firms. Both Tables 3 and 4 show that

the marginal effect of cash flow for high dividend payout firms is substantially larger than that for low dividend payout firms. This result suggests that the higher the dividend payout, the bigger the commitment to stockholders. It implies a higher probability that dividend outlay competes with fixed investment for the limited pool of finance. Facing negative shocks, high dividend payout firms will have much more difficulties in financing. This makes their inventory investment be more sensitive to cash flows.

The estimated marginal effect of cash flow for high-indebted firms is 0.369 and that for low-indebted firms is -0.085 . Again this finding is remarkably consistent with what we expect and in line with the evidence in the literature.

Table 3 also shows that the estimated coefficient of cash flow for large firms is insignificant at the 5% significance level. It suggests that contemporaneous cash flow effects do not exist for large firms. This result differs from Carpenter *et al.* (1994). They found evidence that contemporaneous cash flow effects do exist not only for small firms but also for large firms, although the marginal effect for small firms is larger than that for large firms. The reason that Dutch large firms' inventory investments are not sensitive to contemporaneous cash flow shocks may be that most of the large firms in The Netherlands are multinational corporations. They operate on international capital markets and do not face restrictions from domestic capital market imperfections. However, it is still plausible to think that unconstrained firms, in general, should also consider financial factors in adjusting inventories. Unconstrained firms probably respond much more slowly to cash flow shocks than constrained firms. This idea is brought forward by Bernanke *et al.* (1996). To test this hypothesis, the regression was re-run based on Equation 9 by replacing the current cash flow with the lagged-one cash flow. In Table 4 it

Table 2. Fixed effect estimation, Equation 7 Dependent variable: $\Delta V/K$

Explanatory variable	Whole sample	Size		Dividend ratio		Debt	
		Large	Small	Low	High	Low	High
V_{-1}/K	-0.398 [-17.827]	-0.481 [-16.075]	-0.337 [-9.793]	-0.339 [-8.467]	-0.453 [-7.303]	-0.440 [-13.423]	-0.342 [-7.883]
S/K	0.078 [18.181]	0.071 [13.366]	0.082 [11.588]	0.075 [9.286]	0.076 [7.303]	0.057 [9.5119]	0.054 [6.355]
S_{-1}/K	-0.054 [-12.130]	-0.044 [-8.152]	-0.061 [-8.166]	-0.039 [-4.847]	-0.051 [-4.358]	-0.028 [-4.9099]	-0.035 [-4.079]
Implied β	0.060	0.050	0.060	0.106	0.055	0.066	0.056
Implied γ	-0.053	-0.040	-0.060	-0.037	-0.050	-0.027	-0.035
Adjusted R-Squared	0.501	0.608	0.365	0.326	0.646	0.534	0.334
F-Statistic	494.306	378.882	147.225	98.777	126.474	184.099	85.015

Source: Own calculations from dataset taken from *Jaarboek van Nederlandse Ondernemingen*. White heteroscedasticity-consistent t -statistics are in parentheses.

Table 3. *Fixed effect estimation, Equation 9. Dependent variable: $\Delta V/K$*

Explanatory variable	Whole sample	Size		Dividend ratio		Debt	
		Large	Small	Low	High	Low	High
V_{-1}/K	−0.334 [−16.104]	−0.504 [−16.637]	−0.271 [−8.924]	−0.327 [−7.999]	−0.315 [−5.736]	−0.469 [−13.556]	−0.328 [−8.120]
S/K	0.065 [12.745]	0.070 [12.295]	0.061 [7.870]	0.070 [7.380]	0.073 [6.872]	0.070 [9.583]	0.041 [4.538]
S_{-1}/K	−0.052 [−10.247]	−0.040 [−6.966]	−0.054 [−6.834]	−0.036 [−3.972]	−0.076 [16.153]	−0.028 [−4.409]	−0.024 [−2.771]
CF/K	0.403 [9.144]	0.048 [1.619]	0.572 [7.415]	0.128 [2.659]	1.408 [7.207]	−0.085 [−2.778]	0.369 (5.526)
L/K	−0.098 [−7.189]	−0.053 [−3.802]	−0.107 [−5.645]	−0.110 [−3.317]	−0.133 [−1.631]	0.007 [1.973]	−0.162 [−4.139]
Implied β	0.039	0.060	0.026	0.104	−0.010	0.090	0.052
Implied γ	−0.051	−0.039	−0.054	−0.035	−0.077	−0.027	−0.024
Adjusted R -Squared	0.487	0.625	0.399	0.317	0.680	0.526	0.391
F -Statistic	235.397	203.895	83.969	48.211	73.540	89.924	53.224

Source: Own calculations from dataset taken from *Jaarboek van Nederlandse Ondernemingen*.

White heteroscedasticity-consistent t -statistics are in parentheses.

Table 4. *Fixed effect estimation, the lagged cash flow effects dependent variable: $\Delta V/K$*

Explanatory variable	Whole sample	Size		Dividend ratio		Debt	
		Large	Small	Low	High	Low	High
V_{-1}/K	−0.364 [−16.915]	−0.507 [−16.734]	−0.303 [−10.014]	−0.344 [−8.422]	−0.390 [−6.883]	−0.456 [−13.399]	−0.351 [−8.141]
S/K	0.078 [16.841]	0.073 [13.448]	0.081 [10.742]	0.077 [8.872]	0.089 [6.629]	0.061 [9.336]	0.051 [5.567]
S_{-1}/K	−0.057 [−11.915]	−0.042 [−7.158]	−0.065 [−8.388]	10.039 [−4.360]	−0.072 [−4.776]	−0.026 [−4.130]	−0.029 [−3.354]
CF_{-1}/K	0.264 [7.401]	0.038 [1.290]	0.448 [7.550]	0.060 [1.456]	0.466 [3.095]	−0.023 [−0.720]	0.177 [2.881]
L/K	−0.075 [−0.835]	−0.048 [−3.720]	−0.093 [−4.924]	0.032 [−2.745]	−0.063 [−0.883]	0.001 [0.231]	−0.124 [−3.103]
Implied β	0.058	0.061	0.053	0.110	0.044	0.077	0.063
Implied γ	−0.056	−0.041	−0.064	−0.038	−0.071	−0.025	−0.028
Adjusted R -Squared	0.479	0.625	0.419	0.317	0.583	0.534	0.359
F -Statistic	228.468	203.338	89.986	48.255	49.822	92.458	47.317

Source: Own calculations from dataset taken from *Jaarboek van Nederlandse Ondernemingen*.

White heteroscedasticity-consistent t -statistics are in parentheses.

appears that the lagged cash flow coefficient is still insignificant for large firms. Moreover, the cash flow effect for the other two unconstrained groups disappear. In this sense this experiment provides the robustness test for the test in Table 3. The country specific characteristics of Dutch large firms rules out the cash flow effect on inventory investment. We also notice that the counterparts of the structural parameters seem to be fairly robust.

V. CONCLUSIONS

This paper uses a firm-level panel dataset to explain inventory investment of Dutch firms. The study offers some evidence that Dutch firms are stockout avoidance motivated. It proves that capital market imperfections are relevant to explaining inventory behaviour of Dutch firms. The results show that inventory investment of the firms that are likely

to be financially constrained respond much more sharply to cash flow shocks than firms that are likely to be financially unconstrained. In contrast to studies on inventory investment for other countries, inventory investment of large Dutch firms is not sensitive to cash flows. This suggests that for this group of firms capital market imperfections are not relevant, which can be explained by the fact that in The Netherlands almost all large firms are multinationals.

Most importantly, the results suggest that the estimates based on the original Lovell model, in which no capital market imperfections are taken into account, underestimates the accelerator effect and the adjustment speed for financially unconstrained firms and overestimates them for constrained firms. This implies that inventory investment should be partly explained by the existence of capital market imperfections. The misspecification of the stock adjustment equation caused by the omitted variable makes the estimated values of the structural parameters in the original Lovell model biased. Hence, augmenting the Lovell model with proxies for capital market imperfections, as has been done in this study, seems to be very important for obtaining more accurate estimates of the true inventory investment model. This certainly holds for the Dutch case. Since almost all countries are plagued by capital market imperfections, this will probably be the case in general.

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